Femoral Intercondylar Notch (ICN) width in Nigerians: Its relationship to femur length

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Summary

We have investigated and measured the Femoral Intercondylar Notch (ICN) width in Nigerians and found the mean to be 2.24cm (22.4mm). The Intercondylar Notch (ICN) width ranged from 1.18cm (18.1mm) to 2.80cm (28.0mm). The mean value for the left femur was found to be 2.21cm and 2.27cm for the right femur. It is suggested that the difference could be the result of dominant use of one foot over the other or to occupational habit. This needs further investigation.

The Femoral Intercondylar Notch (ICN) width is not related to Femur length as no relationship was found to exist between the two ($p > 0.05$). We conclude that since stenosed notch individuals are at high risk of Anterior Cruciate Ligament (ACL) injuries, the normal values of Intercondylar Notch (ICN) width that we have established may be utilized for practical and accurate screening of individuals who are predisposed to Anterior Cruciate Ligament (ACL) ruptures and injuries.

Keywords: ***Intercondylar notch width, Anterior cruciate ligament, Femur length, Femur.***

Résumé

Nous avons étudié et déterminé la largeur Fermorale Intercondylaire Notch (ICN) au Nigeria et noté que le moyen est 2, 24 cm (22,4 mm).

La largeur Inter-condylaire Notch (ICN) varie entre 1,18cm (18,lmm) et 2,80cm (28,Omm). La moyenne de valeur pour le fémur gauche était 2,21cm et 2,27cm pour le fémur droite. On a proposé que la différence pourrait être à la suite de la prédominance en ce qui concerne l'utilisation d'une jambe par rapport à l'autre ou peut-être à cause de l'habitude professionnelle. Ceci exige des recherches plus approfondies.

La largeur Fémorale Intercondylaire Notch (ICN) n' a aucun rapport avec la largeur du fémur puisqu'on n'avait pas noté aucun rapport existant entre les deux ($P > 0$; 05). Nous concluons que puisque l'individu souffrant de sténose notch sont en grand danger des blessures Ligaments Crusciates Qnterieures (ACL) les valeurs habituelles de la largeur Intercondylaire Notch (ICN) que nous avons confirmé pourrait être utilisé pour un dépistage pratique et exact des individus qui sont prédisposent aux hernie et blessures Ligaments cruciates Antérieures.

Introduction

The femur is the longest and strongest bone of the human body. It is the bone of the thigh. It has proximal and distal extremities with an intervening shaft. While its upper (proximal) extremity is involved in the stable ball and socket hip joint, the lower (distal) extremity is involved in the relatively unstable knee joint. The stability of the knee joint depends mainly on ligaments and muscular tendons around it rather than the bony articular surfaces.

The lower extremity of the femur presents at its anterior surface a saddle shaped groove that is the patella surface, while posteriorly the condylars are separated by a U-shaped fossa called the Intercondylar Notch (ICN).

The interest of this study is on the Intercondyla Notch (ICN) width, because it is becoming important in injuries affecting the cruciate ligaments in both sportsmen and women.[1] Anderson *et al* 1987[(2)] used the CT scan to measure the Intercondylar Notch (ICN) width and concluded that an association exists between anterior outlet stenosis of the Intercondylar Notch (ICN) and rupture. In another study on patients with acute Anterior Cruciate Ligament (ACL) injuries and subjects with no known knee injuries, using the computer graphic study, it was stressed that a narrow posterior notch may predispose to Anterior Cruciate Ligament (ACL) failure.[3]

The Notch Width Index (NWI) is the ratio of the width of the Intercondylar Notch (ICN) to the width of the distal femur at the level of the popliteal groove.[4] It had been measured using the notch radiographic view in a prospective study in 902 high school athletes and it was found that athletes with no contact Anterior Cruciate Ligament (ACL) injuries have smaller notches, and that the Notch Width Index (NWI) is less in women compared to men. In a similar study, it was concluded that athletes with stenosed notches involved in certain sports are at a high risk of Anterior Cruciate Ligament (ACL) injuries.[5]

Nevertheless, Schickendatz and Weiker in 1993[(6)] used eight Norwegian handball players, from radiographic views and concluded that notch measurements from radiographs may not be reliable predictors of Anterior Cruciate Ligament (ACL) injury.

Good *et al* in 1991[(7)] used the caliper technique to measure the Notch Width Index (NWI) and found the Intercondylar Notch (ICN) width to range from 18.1 to 20.4 mm (1.81cm to 2.04cm), they also observed that patients with Anterior Cruciate Ligament (ACL) injuries had narrower notches.

All the studies reported above have been done outside Africa, we therefore, set out to determine the normal Intercondylar Notch (ICN) width in Nigerians and to determine if it had any relationship with the length of the femur.

Materials and Method

The simple materials used in this study include a well calibrated ruler, a pair of dividers from a mathematical set, a sliding caliper, a sharp pointed marker pen, one hundred (100) femur bones and a measuring tape.

The bones consisted of 68 right femur bones and 32 left femur bones. They were definitely bones of adult Nigerians with ages between 20 and 40 years. The sex of the individuals was not considered.

The bones were collected over a period of two years from anatomy Dissection Laboratories of University of Port Harcourt, University of Calabar, University of Benin, Nnamdi Azikiwe University, Awka and Abia State University Uturu, all in Nigeria. Once the bones were collected., they were cleaned and properly treated for preservation by the prosecutor at Nnamdi Azikiwe University. The procedure for cleaning and preservation is as follows: the bones were soaked in clean water at 60-65°C for about 12 hours to destroy the periosteum (simmering), the bones were next soaked again in clean water at 37°C for 2 weeks to ensure proper maceration of tissues. At the end of 2 weeks the bones were soaked in 2% caustic soda for 1-4 hours, to remove any remaining tissues, which were brushed off with a brush and the bones rinsed in cold water. The bones were once again soaked in 10% hydrogen peroxide for about 2 weeks and then rinsed in running water to

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remove any trace of the hydrogen peroxide. The bones were finally allowed to dry in the sun for 1 - 2 days.

Measurement

The measurements were made by caliper technique and directly from the bones as in Fig. 1. The points A and B were marked out with a marker pen, they represent the superior and inferior limits of the medial surface of the Intercondylar Notch (ICN). Then, points C and D were also marked out representing the superior and inferior limits of the lateral surface of the Intercondylar Notch (ICN). The points of the pair of dividers were then placed at A and B and then on the calibrated ruler to get the actual length of A- B. The mid point of this line is half the length of AB which is marked out as E. The process was repeated for line CD to get it's mid point at F. The Intercondylar Notch (ICN) width (E-F) was then measured to the nearest mm using the pair of dividers and the calibrated ruler and confirmed with the venier sliding caliper. The length of each femoral shaft was measured from the lower end of the lesser trochanter to the upper limit of the medial supracondylar ridge using a calibrated measuring tape.

The correlation coefficient was used to determine the relationship between the Intercondylar Notch (ICN) width and the length of femur shaft.

Result

Table 1 shows the mean Intercondylar Notch (ICN) width which is 2.24cm (22.4mm) as determined from this study and the mean femoral shaft length to be 33.6cm (336mm). The standard deviation and error are also presented in the table. The difference between left and right Intercondylar Notch (ICN) width is compared in Table 4. It shows that the right femoral bones tended to have slightly wider Intercondylar Notch (ICN) width, 2.21cm for the left and 2.27cm for the right femoral bones.

Table 1 Intercondylar Notch (ICN) width and shaft length in 100 femur bones.

	Mean	Mode	Median	SD	SE
ICN width(CM)	2.24	2.25	2.20	5.77	0.591
Shaft length (CM)	33.6	35.59	33.53	3.36	0.336

Table 2 Frequency of occurrence of Intercondylar Notch (ICN) width in 100 femur bones

Icn Width (cm)	Frequency
1.8	4
1.9	5
2.0	18
2.1	13
2.2	15
2.3	9
2.4	11
2.5	14
2.6	3
2.7	2
2.8	6
	100

Table 3 Frequency of occurrence of femur shaft length in 100 femur bones

Length (cm)	Frequency	X-Mark
25.5 - 27.4	5	26.45
27.5 - 29.4	7	28.25
29.5 - 31.4	2	30.45
31.5 - 33.4	28	32.45
33.5 - 35.4	25	34.45
35.5 - 37.4	30	36.45
37.5 - 39.4	3	38.45
	100	

Table 4 Comparison of left and right femoral Intercondylar Notch (INC) width (cm)

	Mean	Mode	Median	SD
Left Femurs (n=32)	2.21	2.00	2.20	4.47
Right Femurs (n - 68)	2.27	2.50	2.20	7.47
Combined Left and Right (n-100)	2.24	2.25	2.20	5.77

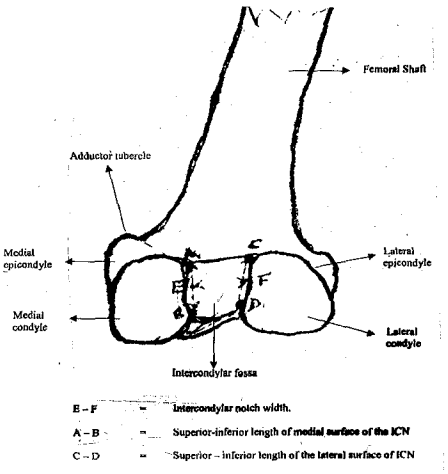

Fig. 1 *The posterior view of lower end of femur showing how measurement of ICN width was made.*

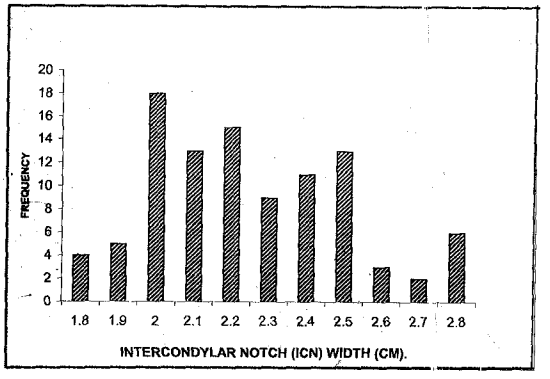

Fig. 2 *Frequency of occurence of intrecondylar notch (ICN) width in 100 femur bones.*

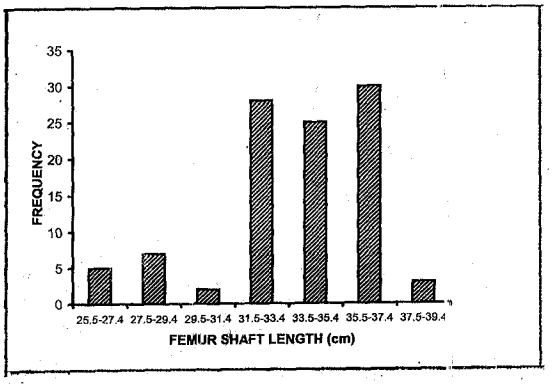

Fig. 3 *Frequency of occurence of shaft length in 100 femur bones.*

Table 2 shows the frequency of occurrence of Intercondylar Notch (ICN) width which shows that more of the bones tends to have an Intercondylar Notch (ICN) width of between 2.00cm to 2.50cm and this is graphically presented in Fig. 2. In the addition, the frequency of occurrence of femoral shaft length is shown in Table

3. More femoral bones tend to have a length of between 31.5cm and 37.4cm. This is also graphically represented in Fig. 3.

There was no statistically significant correlation between femur length and Intercondylar Notch (ICN) width ($r=0.256$; $p > 0.05$) among the bone specimens used for this study.

Discussion

The seemingly simple measurement of Intercondylar Notch (ICN) width took a period of two years to be completed because of the difficulty in obtaining the bones in the first instance and also the time it takes to clean, prepare and dry the bones. The dependence on five centers of collection however facilitated the process.

Many method of measuring the Intercondylar Notch (ICN) width exist. However, measurements from readily available radiographs have been criticized as being unreliable.[6] Both CT scan and computer graphic study methods are not available to us. We therefore chose the caliper technique, which is both easy and reliable. We found the Intercondylar Notch (ICN) width in Nigerians to range from 1.8cm (18.0mm) to 2.8 cm (28.0mm) with a mean value of 2.24 cm (22.4mm). Our lower value of 18mm is comparable to the lower value obtained for Caucasians in the recent study of Good *et al* (1997)[7] who reported the range of Intercondylar Notch (ICN) width to be between 18.1 to 20.4mm using the caliper technique. However, our upper value of 28mm is much higher than that of Good *et al* (1997)[7]. Most textbooks we consulted have not bordered to give the value of Intercondylar Notch (ICN) width and most published articles especially in the area of sports medicine restrict themselves by describing the Intercondylar Notch (ICN) width as either normal, stenosed or narrow[2,3,4,8].

It is therefore too early to state categorically that the Intercondylar Notch (ICN) width is wider in Negroes compared to Caucasians as more studies need to be done in this area. Although, we did not relate our study to Anterior Cruciate Ligament (ACL) injuries, however, it is a known fact that athletes with stenotic Intercondylar Notch (ICN) are at high risk of Anterior Cruciate Ligament (ACL) injury[8,3]. We however, state that knowing the normal Intercondylar Notch (ICN) width value for a population is the first step in determining members of the same population who are predisposed to Anterior Cruciate Ligament (ACL) ruptures and injuries.

Our findings in Table 4 suggest that the Intercondylar Notch (ICN) width might be wider on one side than the other, in our case the right side tended to have higher values. We have no immediate reason for this finding except to say that it is a known fact that in most bilateral structures, one is large than the other. It could however, be related to the dominant limb in use or to occupational habit in a given population. More studies needs to be done using equal numbers of right and left femurs to determine the possible relationship between left and right Intercondylar Notch (ICN) width. Femoral length was measured in this study mainly to determine its relationship to the Intercondylar Notch (ICN) width. No relationship was found to exist between the two ($p > 0.05$), what therefore determines the width of the Intercondylar Notch (ICN) is yet unknown and needs further investigation.

We conclude by stating that the normal limits of the Intercondylar Notch (ICN) width now established for Nigerians is of additional clinical significance as it may be utilized for practical and accurate screening of individuals who are predisposed to Anterior Cruciate Ligament (ACL) injuries.

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